

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY



(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 19 MAY 2006

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Applicant's or agent's file reference 11321-P071WO	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/US2004/024507	International filing date (day/month/year) 29.07.2004	Priority date (day/month/year) 29.07.2003
International Patent Classification (IPC) or national classification and IPC INV. C01B31/02		
Applicant WILLIAM MARSH RICE UNIVERSITY		
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input type="checkbox"/> sent to the applicant and to the International Bureau a total of sheets, as follows:</p> <p><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>		
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the report</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>		
Date of submission of the demand 24.02.2005	Date of completion of this report 18.05.2006	
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized officer Siebel, E Telephone No. +31 70 340- 	

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/US2004/024507

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-20 as originally filed

Claims, Numbers

1-24 as originally filed

Drawings, Sheets

1/6-6/6 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing *(specify)*:
 - ☐ any table(s) related to sequence listing *(specify)*:
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing *(specify)*:
 - ☐ any table(s) related to sequence listing *(specify)*:

* If item 4 applies, some or all of these sheets may be marked "superseded."

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Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	3,6, 8,11-24
	No: Claims	1,2,4,5,7,9,10
Inventive step (IS)	Yes: Claims	13-24
	No: Claims	1-12
Industrial applicability (IA)	Yes: Claims	1-24
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V.

- 1 Reference is made to the following document:

D1 : WO 02/060812 A (cited in the application)

D2 : R. Krupke et.al., Science 2003, 301, 344-347

- 2.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1,2,,4,5,7,9,10 is not new in the sense of Article 33(2) PCT.

Document D1 discloses a process for derivating a SWNT by reacting the SWNT with a diazonium species generated in situ by reacting an aniline derivative with an alkyl nitrite. The process comprises the steps of suspending the carbon nanotubes (i.e. SWNT's) in an organic solvent and reacting said suspended carbon nanotubes with an anilline derivative, adding isoamyl nitrite in order to produce in-situ the diazonium salt, followed by stirring the suspension at 60°C and recovering the functionalised product (see D1, page 10, line 8 to 29; page 15, line 6 to line 35; claim 1,2,4, 5, 6). D1 also discloses, that the carbon nanotubes can be defunctionalised by heating to 600°C (see D1, page 16, line 5 to line 19).

- 3.1. The subject-matter of claim 3 therefore differs from this known process in that an aqueous surfactant suspension of carbon nanotubes is prepared in a first step.

The subject-matter of claim 3 is new in the sense of Article 33(2) PCT.

- 3.2. The problem to be solved in view of the distinguishing feature may therefore be regarded as to provide a suspension of individual SWNT's.
- 3.3. The solution proposed in claim 3 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reason.
- 3.4. SWNT's are typically grown together as bundles which are either already present or formed in suspension because of van der Waals interactions. It has been shown, that stable suspensions with high yields of individual SWNT's can be obtained by homogenizing a suspension of SWNT's in water in presence of a surfactant (here

sodium dodecyl sulfate (SDS) (see D2, page 344, left column, line 1 to page 345, left column, line 12).

3.5. Dependent claims 4-12 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step.

4.1. Document D2 discloses a process for separating carbon nanotubes (metallic, semi metallic, semi-conductive) on the basis of their electronic bandgap via dielectrophoresis.

4.2. The subject-matter of claim 13 therefore differs from this known process in that selectively functionalised carbon nanotubes are separated.

The subject-matter of claims 13 is new in the sense of Article 33(2) PCT.

4.3. The problem to be solved in view of the distinguishing feature may therefore be regarded as providing a process for the separation of semiconducting from metallic and semi-metallic carbon nanotubes with high selectivity.

4.4. The solution proposed in claim 13 of the present application can be considered as involving an inventive step (Article 33(3) PCT) for the following reason.

4.5. The cited prior art does not disclose or mention, that metallic and semi-metallic carbon nanotubes will be functionalised when reacting with a diazonium salt, while semiconducting carbon nanotubes would not.

Due to the selective functionalization of the carbon nanotubes, the separation (step b of claim 13) of the metallic and semi-metallic carbon nano-tubes from the semiconducting carbon nanotubes can indeed be carried out with a higher selectivity.

4.6. The same objection applies mutatis mutandis to the subject-matter of claim 14, 20 and 23.

4.7. Claims 15-19, 21-22,24 are dependent on claims 13,14,20 and 23 respectively and as such also meet the requirements of the PCT with respect to novelty and inventive

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(SEPARATE SHEET)**

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step.